Lesson 16: The Systems Engineering Process Environment

Systems Engineering Process (SEP) Disciplines

The various disciplines of Systems Engineering:

- Exist to support the customer.
- Are tied together by the IPPD process.
- Are coordinated and integrated by the IPTs.

Integrated Product and Process Development (IPPD)

IPPD is a management technique that simultaneously integrates all essential acquisition activities through the use of multidisciplinary teams to optimize the design, manufacturing, and supportability processes. IPPD facilitates meeting cost and performance objectives from product concept through production, including field support. One of the key IPPD tenets is multidisciplinary teamwork through Integrated Product Teams (IPTs). (Source: DOD 5000.2-R, Section C, Paragraph 5)

Integrated Product Teams (IPTs)

The Secretary of Defense has directed that the Department perform as many acquisition functions as possible, including oversight and review, using IPTs. These IPTs shall function in a spirit of teamwork with participants empowered and authorized, to the maximum extent possible, to make commitments for the organization of the functional area they represent. IPTs are composed of representatives from all appropriate functional disciplines working together to build successful programs and enabling decision-makers to make the right decisions at the right time. (Source: DOD 5000.2-R, Part 1, Section 1.6)

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Introduction to the SEP Environment

Several disciplines support the overall Systems Engineering Process (SEP):

- Systems Engineering
- Science and Technology
- Test and Evaluation
- Acquisition Logisitics
- Software Engineering
- Production, Quality, and Manufacturing Management

Systems Engineering

Systems Engineering involves design and management of a total system that includes hardware and software, as well as other system life-cycle elements. The Systems Engineering Process is a structured, disciplined, and documented technical effort through which systems products and processes are simultaneously defined and developed.

Systems Engineering is most effectively implemented as part of an overall IPPD effort using multidisciplinary teamwork. (Source: Defense Acquisition Deskbook, 30 Sept 97, Information Structure, Systems Engineering Process 2.6)

Science and Technology

Science and Technology transitions technological developments for use by operational forces. Science and Technology programs:

- Demonstrate new and emerging technologies that have a direct application to military systems.
- Are intended to be implemented into future military systems to support military needs, solve military problems, and provide a sound basis for acquisition decisions.

(Source: Defense Acquisition Deskbook, 30 Sept 97, Information Structure, Science and Technology Topic 2.2)

Test and Evaluation

Test and Evaluation is a process that compares a system or components against requirements and specifications through testing. The results are evaluated to assess progress of design, performance, supportability, etc.

Developmental Test and Evaluation is an engineering tool used to reduce risk throughout the defense acquisition cycle. Operational Test and Evaluation involves the actual or simulated employment, by typical users, of a system under realistic operational conditions.

(Source: Defense Acquisition Deskbook, 30 Sept 97, Information Structure, Test and Evaluation Topic 2.8)

Acquisition Logistics

Acquisition Logistics is a multifunctional, technical management discipline associated with the entire life cycle of a system. The principle objectives of Acquisition Logistics are to ensure that:

- Support considerations are an integral part of the system's design requirements so that the system can be cost-effectively supported throughout its life cycle.
- The infrastructure elements necessary for the initial fielding and operational support of the system are identified and developed and acquired.

The majority of a system's life-cycle costs can be attributed directly to operations and support costs after the system is fielded. Because these costs are largely determined early in the system development period, it is vitally important that system developers evaluate the potential operational and support costs of alternative designs and factor these into early design decisions. (Source: Defense Acquisition Deskbook, 30 Sept 97, Information Structure, Acquisition Logistics 2.6.J)

Software Engineering

Software Engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of systems engineering to software.

In general, software engineering comprises all the activities performed to support the translation of a user need into a product. That product includes hardware and software.

DOD Software Acquisition Management requires an understanding and application of best

management practices and regulatory requirements that apply to the software planning, acquisition, qualification, and system integration of DOD Automated Information Systems (AIS), Command, Control, Communications, Computers and Intelligence (C4I) Systems, and Weapon Systems.

Production, Quality, and Manufacturing Management
(Called Manufacturing and Production in Deskbook)

The goal of the Production, Quality, and Manufacturing Management discipline is to ensure the producibility of the system design. Producibility is the relative ease of manufacturing an item or system. Designing in producibility reduces both schedule and cost risks.

Manufacturing and Production activities are those activities in weapon system acquisitions associated with the concurrent development and maturation of the product design for producibility and the related new or modified manufacturing processes, and the establishment of the needed production capability. Effective design for producibility can accelerate product introduction, increase quality, and reduce overall cost. Designing in producibility reduces the risk in both schedule and cost for design changes later, when costs to change are much higher. Producibility and manufacturing process efforts should start not later than Milestone I, Approval to Begin a new Acquisition Program, and continue through production. (Source: Defense Acquisition Deskbook, 30 Sept 97, Information Structure, Manufacturing and Production. 2.6.D)

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Roles and Responsibilities

Technical Management Partnership

The Government and Contractor work together as part of the IPT process to transform broad operational requirements into a fielded system.

The Government is concerned primarily with:

- Managing the total program.
- Meeting the user's requirements.

The contractor is concerned primarily with:

- Designing and developing the system.
- Meeting the Government's contractual requirements.

Comparison of Government and Contractor Activities

The Government and Contractor may perform similar activities. However, each party has a distinct role.

Function	Government Role	Contractor Role
Translate the Need	Translates the operational need into a performance specification.	Translates the system performance specification into technical design specifications.
Define the Design	Establishes system-level performance thresholds and objectives.	Allocates system-level performance thresholds and objectives to subsystems and lower.

Monitor the Design	Monitors program technical progress through IPTs, technical reviews, and periodic program reviews.	Manages and integrates technical design progress using internal management standards.
Assure Design Quality	Verifies contractor performance through review and approval of contractor technical deliverables.	Validates internal and subcontractor technical performance through established quality control standards.
Test the Design	Verifies system performance through conduct of development and/or operational testing.	Validates system performance through internal testing and participation in Government development testing.

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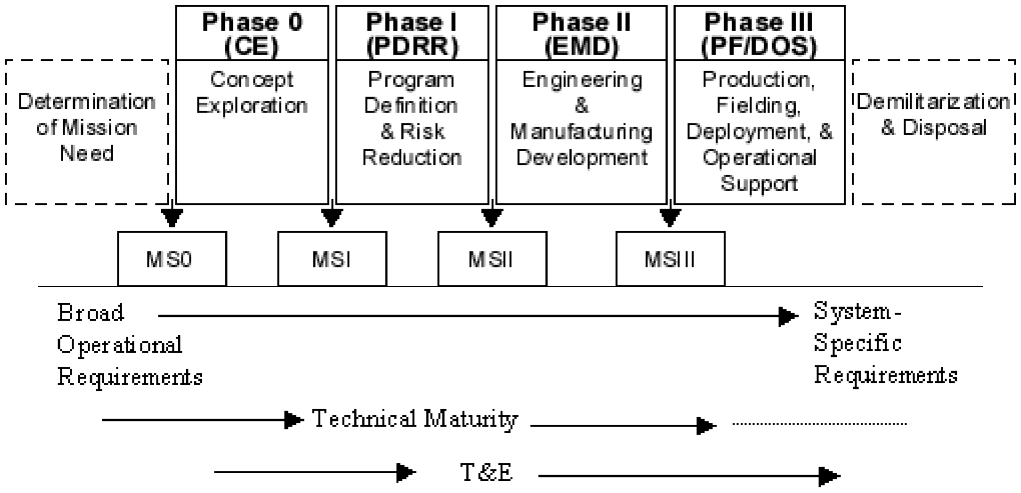
Systems Engineering Process (SEP) Integration

Systems Engineering Disciplines and the Acquisition Life Cycle

The various Systems Engineering activities must be progressively integrated across all phases of the life cycle. These activities must be tailored to fit program needs.



Determination of Mission Need

All acquisition programs are based on identified, documented, and validated mission needs. Mission needs result from ongoing assessments of current and projected capability. Mission needs may seek to establish a new operational capability, to improve an existing capability, or to exploit an opportunity to reduce costs or enhance performance. (If the mission needs cannot be met through the use of non-material solutions (such as change tactics or modify force structure), the need is documented in a Mission Needs Statement (MNS) and validated as discussed in a previous lesson.)

(Source: DOD 5000.2-R, Section 1.4.1)

Concept Exploration

Phase 0 typically consists of competitive, parallel short-term concept studies. The focus of these efforts is to define and evaluate the feasibility of alternative concepts and to provide a basis for

assessing the relative merits (i.e., advantages and disadvantages, degree of risk) of these concepts at the next milestone decision point.

The Analysis of Alternatives is used to facilitate comparisons of alternative concepts. The most promising system concepts are defined in terms of initial, broad objectives for cost, schedule, performance, software requirements, opportunities for tradeoffs, overall acquisition strategy, and test and evaluation strategy.

Following this comparative analysis, the most promising and cost-effective concepts are identified. Based on the preferred concept, the Operational Requirements Document (ORD) is prepared. The preliminary system performance specification is developed to guide conduct of technical management activities in the next phase. (Source: DOD 5000.2-R, Section 1.4.2)

Program Definition and Risk Reduction (PDRR)

During this phase, the program becomes defined as one or more concepts, design approaches, and/or parallel technologies are pursued as warranted. Assessments of the advantages and disadvantages of alternative concepts are refined.

The goal of PDRR is to fully allocate all requirements down to appropriate levels of item performance specifications in order to complete the design. Prototyping, demonstrations, and early operational assessments are included as necessary to reduce risk so that technology, manufacturing, and support risks are well in hand before the next design point.

Based on the selected prototype design, a final system performance specification is prepared to guide the chosen contractor/contractor team in the conduct of detailed design and development during the next phase. Other critical tasks in this phase include: 1) identification of technical design, development, and manufacturing risks, and 2) design of the support system.

Engineering and Manufacturing Development

The primary objectives of this phase are to translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing or production process; and demonstrate system capabilities through testing. Low-Rate Initial Production (LRIP) occurs while the Engineering and Manufacturing Development phase is still continuing, as test results and design fixes or upgrades are incorporated.

Government development and/or operational testing of Engineering Development Models (EDMs) and/or LRIPs will be conducted to ensure that risks have been overcome and that the EDMs and/or LRIP items meet established performance thresholds and objectives. Quantitative and qualitative support system requirements are also identified in this phase. Post-production support planning also begins in this phase. (Source: DOD 5000.2-R, Section 1.4.4)

Low-Rate Initial Production (LRIP) Quantities

The objectives of this activity are to produce the minimum quantity necessary to provide production configured or representative articles for operational test, and thus establish an initial production base for the system; and to permit an orderly increase in the production rate for the system, sufficient to lead to a full-rate production upon successful completion of operational testing. (Source: DOD 5000.2-R, Section 1.4.4.1)

Engineering Development Model (EDM)

A production representative system used during the Engineering and Manufacturing (EMD) phase to resolve design deficiencies, demonstrate maturing performance, and develop proposed production specification and drawings.

Production, Fielding/Deployment, and Operational Support

In this phase, production capability of the chosen contractor is verified, and full-rate production begins. The objectives of this phase are to achieve an operational capability that satisfies mission needs. Deficiencies encountered in Developmental Test and Evaluation (DT&E) and Initial Operational Test and Evaluation (IOT&E) shall be resolved and fixes verified. (The production requirement of this phase does not apply to ACAT IA acquisition programs or software-intensive systems with no developmental hardware components.) (Source: DOD 5000.2-R, Section 1.4.5.1)

Demilitarization and Disposal

At the end of its useful life, a system must be demilitarized and disposed of. During demilitarization and disposal, the PM shall ensure that material determined to require demilitarization is controlled and that disposal is carried out in a way that minimizes DOD's liability due to environmental, safety, security, and health issues. (Source: DOD 5000.2-R, Section 1.4.6)

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